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XVI.—*On the Ground Ice or Frozen Soil of Siberia.* By Professor BAER. Communicated by Admiral KRUSENSTERN. Read February, 1838.

IT was remarked long ago that there is a large extent of country in Siberia where the soil never thaws. In summer, when the temperature is in some districts considerable, the ground becomes warm to a greater or less depth, and thawed, but lower down the ice is again met with. Gmelin, the elder, in his travels in Siberia, states that at Yakutsk, shortly after the foundation of that town, towards the end of the seventeenth century, the soil was found frozen at a depth of thirteen sashes, or ninety-one feet, so that the inhabitants were obliged to give up the idea of sinking a well. Many similar cases were brought forward by persons sent out by the Academy of Sciences of St. Petersburgh about the middle of last century, but these do not appear to have been generally believed. In 1825 Leopold von Buch, a philosopher of high authority upon all questions relating to the physical condition of the earth, rejected them as erroneous; they have, however, been corroborated in our time by Erman and Humboldt.

In his paper published in the transactions of the Academy of Berlin, Von Buch says, "I am fully convinced that the accounts of the soil being frozen in summer to the depth of many feet, in districts capable of maintaining the growth of shrubs and bushes, are not to be relied on, and that Gmelin's statement that the soil was frozen in a well at Yakutsk at the depth of 100 feet, ought no longer to be quoted in elementary works upon natural philosophy. The accounts given by the Cossacks, who in all probability did not like the labour of sinking the well at Yakutsk, and who were dead before Gmelin extracted the information from reports at Yakutsk, cannot be sufficient proof of a fact so extraordinary and so much at variance with physical science. In Hudson's Bay, where the average degree of temperature is much below the freezing point, there are springs which run under a crust of snow and ice all through the winter." (*Captain James*, 1631; *Memoirs of the Royal Academy of Berlin*, 1825.)

The objections of this philosopher are founded partly on his opinion that cold cannot penetrate so far under the surface, and partly on the story of the springs at Hudson's Bay flowing the whole year round; but if this statement is correct, may not these springs, flowing from under the ice, be thermal springs? Other persons have questioned the existence of perpetual ice in Siberia, as being in direct opposition to the modern experiments, which show that the heat of the earth increases directly as the distance from the surface. It was not known till very lately how deep the

frozen bed extended: for the first information on this subject we are indebted to a merchant of Yakutsk, of the name of Schargin, who carried on an experiment for several years for this purpose. His object at the beginning was to sink a well, but when there was no longer any chance of getting water, and he was about to discontinue his work, Admiral von Wrangel requested him to go on until he reached the bottom of the ice: he did this, and kept a journal of the progress of the work, which he sent to the admiral, and a communication to the Academy of Sciences respecting it was made by M. von Helmerson.

The well was sunk to a depth of 54 sashes, or 382 feet, when the soil became so loose that it was impossible to proceed without timbering, which had been unnecessary nearer the surface. At this depth M. Schargin ascertained the temperature of the earth to be $-\frac{1}{2}^\circ$ Réaumur, but nearer the surface it had been much lower:—

— 6° Réaumur at some feet below the surface.

— 5½° R. at 77 feet.	— 1½° R. at 305 feet.
— 4° „ 119 „	— ½° „ 350 „
— 2° „ 217 „	— ½° „ 382 „

It is probable on looking at this table that in the last observation a greater degree of cold is assigned to the ground than it really has. Besides, as the work was carried on in winter as well as summer, and the mouth of the pit was eight feet square, so large a volume of cold air must have penetrated as to chill the sides—I am therefore inclined to believe that the freezing point must have been reached. The immense thickness of the layer of ground ice (which at Yakutsk is not less than 382 feet) proves that Siberia must have been in the same physical condition for a long period of years as it is at present.

It is impossible to determine accurately, in the present state of our information on this subject, what is the boundary of this layer of ground ice; we only know enough to say that it extends over an immense tract of country. Humboldt found the soil frozen at a depth of six feet at Bogoslovsk, in 59° 44′ N. lat., near the Uralian chain. Near Beresov, Erman found the temperature of the soil, at a depth of twenty-three English feet, to be + 1°; but in 1821 a dead body was found which had been buried upwards of ninety-two years in a bed of ground ice, and which showed no signs of decomposition. It has long been known that the soil at Obdorsk, a town situated some degrees further north, is always frozen. There is no ice at Tobolsk, but the further we proceed to the east the more the direction of the ice is to the south. Georgi found it on the banks of Lake Baïkal, which, however, is in a mountainous country, and it is said to be found east at Nertchinsk, on the banks of the river Argún, but here also in an ele-

vated tract of country. No ice is found at Okhotsk, and the soil is in general warmer on the shores of the Pacific.

The ice, of course, melts more or less every summer, in proportion to the greater or less degree of heat, but old authors assert that the warmth has only the effect of thawing the surface: this is a mistake, which arises from the measurements having been taken at too early a period of the summer, and having then been looked on as the mean of the effect of the heat during the summer months, and as the greatest depth to which the heat penetrated. I have seen ice at a depth of six inches under a soil covered with moss and lichens in the month of July at Novaïa Zemlïa, whilst in a contiguous situation, where the soil is without any signs of vegetable life, it occurs at a depth of two feet. But when winter recommences, which is generally about the beginning of September, the soil in the southern division of Novaïa Zemlïa is thawed to the depth of $2\frac{1}{4}$ to $2\frac{3}{4}$ feet, and it may be true that the soil on the coasts of the Icy Sea, at the mouths of the rivers Obi and Yeniseï, is sometimes free from ice to more than a foot in depth, and the surface is covered with vegetation.

I have no doubt that the Academy of Sciences at St. Petersburgh will repeat the measurements of temperature at the different depths in a better manner and on better principles than M. Schargin could adopt, and endeavour to ascertain the depth to which the heat penetrates at Yakutsk as well as in other places, and also the extent of the ground ice.

It would be very desirable, also, that the Geographical Society of London should collect information respecting the extent of the layer of ground ice in North America, the thickness it attains, and how much of it disappears, particularly in those countries over which the factories of the Hudson's Bay Company extend.

As connected with the same subject, the following extract from a letter of Prof. ADOLPH ERMAN, dated Berlin, March 5, 1838, is subjoined:—

"I see by a report recently published of one of your meetings that some members doubt the reality of the fact that the soil in some parts of Siberia does not thaw till a depth of 400 feet from the surface is reached. Permit me to draw your attention to the observations I have made on this subject, recorded in the Second Volume of my Journey round the World, p. 248, *et seq.* The well at Yakutsk, a notice of which Admiral Krusenstern has sent you, existed when I was in that town; it had then a depth of 50 feet, and in plunging my thermometers into the clods of earth which were dug up before me, and guarding them carefully from the influence of atmospheric temperature, they constantly marked —6° of Réaumur.

"The latitude of the place, however, is only 62° $1\frac{1}{2}'$ N., according to the result of all my observations; a mean temperature, therefore, even

lower than that which Mr. Scoresby assigns to the north of Spitzbergen, might well surprise me until I had seen it perfectly established by observations on the temperature of the air which were made during several consecutive years, and with thermometers compared with my own.

"I enclose the observations taken three times a day for the year 1827, whence it results that the mean temperature of the atmosphere at Yakutsk is — 5°.9 Réaumur, which agrees very well with the temperature which I had found near the surface of the ground.

"I may remark that I have selected a *temperate winter*, for in 1828 the cold in the month of January was much more severe, as the mean of the observation then gave

	At 6 A.M.	2 P.M.	9 P.M.
January, 1838	— 38°.3	— 35°.7	— 37°

and the mercury did not thaw for *three months together*: in ordinary years it is only solid for two months.

"Now the mean temperature of Yakutsk being — 6°, it follows necessarily that if we dig deeper into the earth we must not expect to find the ground thawed till the increment of heat due to the approach towards the centre should amount to 6° of Réaumur.

"The *data* which we hitherto possessed on the increase of the internal heat of the globe, and which have been collected together by Mr. Delabeche in his excellent treatise on Geognosy, indicated from 90 to 100 French feet for an increase of 1° of Réaumur; I did not therefore expect to find the ground thawed at Yakutsk until at a depth of from 500 to 600 French feet (see p. 251 of vol. ii.), and if the actual fact of a thaw at the depth of 400 feet has surprised me, it is only because it has occurred *too soon;* and that it thereby indicates for the strata that compose the ground at Yakutsk a greater faculty for conducting heat than is possessed by the strata hitherto examined in Europe."

XVII.—*An Account of the Recent Arctic Discoveries by* Messrs. Dease and T. Simpson. Communicated by J. H. Pelly, Esq., Governor of the Hudson's Bay Company.

[Just half a century has elapsed since Alexander Mackenzie, in 1789, first descended the great river which so justly bears his name, and reached the waters of the Polar Sea. Thirty-seven years later, in 1826, Franklin and Back followed Mackenzie's course to the mouth of the same river, and coasted 370 miles to the westward, tracing the northern shore of America till within 160 miles of Point Barrow, which was reached from the westward by Mr. Elson, Master of H.M.S. Blossom, only four days after Franklin was obliged to return. The intermediate portion has remained a blank on our maps till the last few days have brought us the gratifying intelligence of an expedition headed by Messrs. Dease and Simpson, two enterprising officers in the Hudson's Bay Company's service, having successfully traced the unexplored country between Point Barrow and Franklin's farthest; and thus a continuous line of 60 degrees in extent, of the northern coast of America, from Point